the girdle increased; consequently the leaves and twigs at the periphery of the tree, where the majority of the fruit buds were formed, did not show such a great variation.

The experiment to determine the effect of fertilizers upon fruitfulness was started with 1-year-old Rome on Paradise stock. The trees were planted in separate large wooden tubs, half of them filled with Missouri River sand and half with loess soil. The fertilizers were applied just as growth was beginning in the spring. It was found that nitrogen was a very decisive factor in the growth of the tree, the development of fruiting wood, and the formation of blossoms. Phosphorus and potassium, either singly or in combination, had no apparent effects.

The effect of various systems of soil management was noted upon the concentration of the cell sap. There were 5 different cultural plots: clean cultivation with soy beans or cow peas planted in June; successive crops of corn; seeded to red clover in alternate years; successive cropping of alfalfa; and permanent timothy sod. "These experiments showed conclusively that tillage methods materially affected the sap density of the twigs of the apple tree." The plots ranked in sap concentration of the twigs as follows: alfalfa; timothy and blue grass sod; clover; corn; and clean cultivation with legume cover planted in June. There was very little difference between the clover and corn plots. The trees in the most intensively cultivated areas were considerably the largest.

A group of 64 one-year-old Delicious trees were used to study the effect of pruning methods upon the formation of fruiting parts. During the first 3 years the trees headed at 2 feet made a greater amount of twig growth and produced a larger number of short branches or potential fruiting wood than did the trees headed at 5 feet. Each month a separate 5- to 6-year-old Jonathan tree was subjected to etherization. Very little effect was observed upon the concentration of the sap of the spurs or of the leaves, and the small difference noted appeared to be only temporary. A rather extensive bibliography accompanies the article.—H. W. RICHEY.

Phylogeny of seed plants.—At the St. Louis meeting of the American Association, the botanical program included a symposium on the phylogeny of seed plants. The three invitation papers have just been published. The three investigators, working upon different phases of the problem, have shown tendencies in the evolution of the groups with which they are concerned; and while the phylogeny of seed plants still represents a great field for exploration, some results have been obtained, and the problem has been advanced a little toward the distant solution.

BUCHHOLZ[7] has made a comprehensive survey of the development of the embryo and polyembryony in the conifers, much of the subject-matter being

[7] BUCHHOLZ, J. T., Embryo development and polyembryony in relation to the phylogeny of conifers. Amer. Jour. Bot. 7:125–145. 1920.

his own contribution. He concludes that the apical cell in early embryogeny, cleavage polyembryony, rosette embryos, rosette cells, and the direct organization of embryo initials from free nuclei of the proembryo are primitive features; while the organization of embryo initials after walls form in the proembryo, a proembryo that fills the entire egg with cells, the archegonium complex, the embryo cap, and the return to simple polyembrony are advanced or specialized features. A study of polyembryony throughout the groups shows that cleavage polyembryony tends to become more or less eliminated in passing from the lower to the higher genera, and consequently the conifers must have been derived from ferns with cleavage polyembryony.

CHAMBERLAIN,[8] in dealing with the Cycads, considered two questions: "What has been their origin?" and "Have they left any progeny?" From a study of the comparative morphology of the entire Cycadophyte phylum, from the Paleozoic to the present time, he concludes that the Cycads could not have come from any Mesozoic forms of the *Cycadeoidea* type, or from any known forms of the Lower Mesozoic. If they have come from any of the Bennettitales, they have come from forms so nearly like the Cycadofilicales, to which the Bennettitales themselves owe their origin, that whether the Cycads are an early branch from the Bennettitales, or have come from the Cycadofilicales directly, can be answered only by fossils still to be discovered and studied.

The second question, so far as the living Cycads are concerned, is answered positively in the negative. The groups of living seed plants are considered separately, and the conclusion reached that the Cycads are not responsible for any of them. This conclusion was emphasized by some facts indicating that the Coniferophytes and Angiosperms have a more reasonable origin in the Ferns or Lycopods. Stress is laid upon the fact that the extinct forms which have been preserved are mostly woody, especially in the Mesozoic. Have herbaceous Gymnosperms been lost which may have given rise to herbaceous Angiosperms? Could such Angiosperms have given rise to the woody Angiosperms which became prominent in the Cretaceous? It is difficult to derive these Angiosperms from any known woody Gymnosperms.

The general conclusion is that the Cycadophytes have come from Ferns, and that they have not left any progeny outside of the Cycadophyte line.

WIELAND[9] deals first with the distribution of seed plants, almost exclusively with fossil seed plants, and then discusses relationships. In living plants, only lateral distribution is considered, but in fossil forms both lateral and vertical distribution must be studied. The vertical distribution, in most cases, is better known than the lateral, and the period of extinction is more determinable than the first appearance. The Carboniferous flora is better

[8] CHAMBERLAIN, C. J., The living Cycads and the phylogeny of seed plants. Amer. Jour. Bot. 7:146–153. 1920.

[9] WIELAND, G. R., Distribution and relationships of the Cycadeoids. Amer. Jour. Bot. 7:154–171. 1920.

known because the economic value of coal has uncovered immense areas; while the Permian, Rhaetic, or Middle Triassic have depended upon the enthusiasm of about a dozen scientists. The flora of these horizons is probably as abundant and varied as that of the Carboniferous, but not so available.

In going back through the geological horizons, there is a gradual merging of Coniferophyte, Cycadophyte, and Ginkgophyte foliage toward seed-bearing "quasi-ferns." Also toward the early Paleozoic there seems to be some kind of contact between the early seed ferns and the older Lepidophyte types leading toward the primitive Gymnosperms. Whether well down in the Devonian some of the Lepidophytes, like the later seed ferns, may also have led into the primitive Gymnosperms is the real riddle of paleobotany, more so than the origin of Angiosperms. In almost all instances the doubtful border of Cycadeoid foliage ends in a tree forest of seed ferns, *Cordaites*, pines, araucarians, and Ginkgoes, but never in a recognizable scrub. It is stated that among the Cycadeoids will be found the lost forests and the greatest forest makers of the Mesozoic.

WIELAND suggests that from age to age great groups have come down side by side, undergoing endless change and losing apparent relationships; but almost no forms, scarcely a family, need be regarded as more ancient or more modern than any other. It is conceivable that all the antecedent types of Angiosperms are discrete separate lines leading back to the first forests of the Devonian.—J. M. C.

History of cotyledony.—BUCHHOLZ,[10] in connection with his studies of embryo development in conifers, has reached certain conclusions in reference to the primitive condition of cotyledony and its subsequent evolution. His investigations showed that in a number of conifers fusions of cotyledons occur during embryogeny, and that there is no evidence of splitting. Fusion results not merely in a reduced number of cotyledons, but often in the development of cotyledonary tubes. The conclusion is that the primitive gymnosperm embryo had numerous cotyledons; that fusions resulted in a reduced number; that dicotyledony was attained either by a fusion of cotyledons into two groups or by an extremely bilabiate development of a cotyledonary tube; and that monocotyledony is the result of a cotyledonary tube becoming "unilabiate" in its development. According to these conclusions, therefore, polycotyledony is primitive, dicotyledony is derived, and monocotyledony is the extreme expression of cotyledonary fusion.—J. M. C.

Life cycle of climbing bamboo.—SEIFRIZ[11] has published some observations on one of the climbing bamboos (*Chusquea abietifolia*) growing in Jamaica.

[10] BUCHHOLZ, J. T., Studies concerning the evolutionary status of polycotyledony. Amer. Jour. Bot. **6**:106–119. *figs. 25*. 1919.

[11] SEIFRIZ, W., The length of the life cycle of a climbing bamboo; a striking case of sexual periodicity in *Chusquea abietifolia* Griseb. Amer. Jour. Bot. **7**:83–94. *figs. 5*. 1920.